

Comparison of census methods to record density and group size of *Ateles geoffroyi*, *Alouatta palliata*, and *Cebus capucinus* in lowland tropical rainforest in Costa Rica. J.D. PRUETZ, Dept. of Zoology, Miami University, Oxford, OH 45056 and H.C. LEASOR, Dept. of Anthropology, California State University, Fullerton, CA 92834.

Besides allowing researchers to assess primates' survival potential, accurate censusing methods provide demographic data on groups or populations that are not fully habituated. We compare the effects of census methods, contact times with groups, and species differences on group encounters and group counts for spider monkeys, howling monkeys, and capuchin monkeys in Costa Rica. In June-August, 1999, sweep transect and walking censuses along established trails were used to assess primate populations in three forest fragments that differed in size and degree of disturbance (i.e., from logging) at La Suerte Biological Field Station. Groups were encountered 152 times during 318 field hours. During 98 hours (on 19 days) of walking censuses, including fruiting tree vigils, and 115 hours (on 28 days) devoted to vegetation analyses, primate groups were contacted 79 times. Contact time with groups ranged from less than a minute to 210 minutes. On 12 days of sweep transects (105 hours) primate groups were contacted 73 times for approximately 30 minutes each contact. Group counts increased with duration of contact time, up to 120 minutes. Spider monkeys were contacted 18 times walking censuses and six times in sweep transects. Howlers were contacted 38 times in walking censuses and 53 times in sweep transects, and capuchins were contacted 19 times in walking censuses and 10 times in sweep transects. Per hour, sweep transects were more efficient in locating howlers, but both census methods were equally successful in locating spider and capuchin groups. Other factors that affect primate density and group size are forest fragment size, degree of forest disturbance, and habitat type availability at La Suerte. Funded by American Society of Primatologists Conservation Grant and Rebecca Jeanne Andrew Memorial Award (Miami University).

Two dental features to place the Neanderthals. P.-F. PUECH, UMR 6569; BP.191, 30012 Nîmes cx4, France.

The morphology of the Neanderthals corresponds to a very complex set of morphological features that have not necessarily the same taxonomic value. Neanderthal roots are distinguishable 600,000 years ago in *Homo heidelbergensis* specimens, named ante-Neanderthals, and a Neanderthal grouping *H. heidelbergensis*-Neanderthal has been proposed (Stringer 1993). Since ancestral condition can reflect a form of iterative evolutionary process (Lahr and Foley 1998), the problem of defining Neanderthal features is central to the debate concerning this hominid sequence.

Variations in considerable alveolar prognathism and in retromolar spaces, that are features that identify Neanderthal, are relevant to dental function. The purpose of this investigation is

to examine this function through the variability of the curve in the sagittal plane of the dental arcade, the curve of Spee, and the breadth ratio of I2 and M2. Harris (1986) obtained from the latters the maximum confidence values for tooth size correlations and component-weights. The curve of Spee was accounted for by scaling all radius of curvature to the same dental arcade length of 46mm (Ré 1997): *Homo erectus* n=7 (73-100), Neanderthal group n=15 (83-149) and *Homo sapiens* n=19 (65-116). The ratio breadth pattern in the *H. erectus* n=19 (.52-.65), Neanderthal group n=9 (.65-.76), early modern man from Skhul n=2 (.61-.66) and robust modern Australian n=600 (.53-.58).

The dental breadth ratio and the curve of Spee make possible a separation between the "Neanderthal group" and the two species *H. erectus* and *H. sapiens*, despite a great range of variation of the curve of Spee. The Skhul "Neanderthaloid" as described by Keith (1939), is removed from the Neanderthal grouping. It is hypothesized that the displacement of the radius range of the *H. erectus* ancestor is a size response to a change in tooth relative position to the basal mandibular bone.

Growth of the cranial base following suturectomy in rabbits with coronal suture synostosis. D.A. PUTZ, M.P. MOONEY, T.D. SMITH, A.M. BURROWS, G. M. COOPER, J. DECHANT, H. W. LOSKEN, M. I. SIEGEL, Anthropology, Univ. of Pittsburgh, Pittsburgh PA 15260 and Physical Therapy, Slippery Rock Univ., Slippery Rock, PA.

It has been suggested that surgical release of synostosed sutures may ameliorate various cranial base abnormalities in craniosynostotic patients. The present study was designed to test this hypothesis in a rabbit model with familial coronal suture synostosis (CSS). Data were collected from 56 New Zealand White rabbits: 11 with unoperated CSS; 13 with CSS released by suturectomy; and 32 unaffected, controls. Suturectomy was performed at 25 days of age. Serial radiographs were taken at 25, 42, and 84 days of age. Linear, angular, and triangular shape measurements of the cranial base were compared using ANOVA and tensor biometric analysis. Results revealed that at 84 days of age, both groups of CSS rabbits had significantly ( $p < 0.05$ ) different anterior and total cranial base lengths, flatter cranial base angles, and dysmorphic anterior cranial base shapes than normals. Significant ( $p < 0.05$ ) differences were noted only for the palatal and cranial base angles and posterior cranial base shape between CSS rabbits with and without suturectomy. However, significant ( $p < 0.05$ ) changes were noted between pre- and postoperative measurements in posterior and total cranial base lengths, and anterior and posterior cranial base shapes in CSS rabbits with suturectomy. Results revealed that surgical release of the synostosed coronal suture through suturectomy did not normalize cranial base growth patterns in CSS rabbits but may have produced acute postoperative changes.

These findings may be explained by a number of

factors, including: resynostosis of the suturectomy site with continued dysmorphic cranial base growth; the relatively late age of surgical release; or that the cranial base abnormalities seen in CSS rabbits may be early primary malformations and not secondary deformations amenable to surgical modification. Supported by NIDR (DE010830) and March of Dimes Birth Defects Foundation.

Determining human migration in the Florida Archaic by strontium isotope ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) analysis of tooth enamel. R.L. QUINN, Department of Anthropology, University of Florida, Gainesville, FL 32611

Strontium isotope ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) analysis has recently been applied to archaeological human skeletal material to elucidate migration at different stages of an individual's life. Strontium isotopes are incorporated into the hard tissue of an organism from the environment of occupation via water and food sources with no biological fractionation. If an organism migrates to an environment with different  $^{87}\text{Sr}/^{86}\text{Sr}$  values, it is possible to detect this movement by measuring  $^{87}\text{Sr}/^{86}\text{Sr}$  of teeth formed at different times during the individual's life.

I use strontium isotope analysis of dental enamel to trace migration of human individuals excavated from the Harris Creek Site (8Vo24), a shell mound/burial site on Tick Island in north-central Florida. Tick Island is an interior island of the St. Johns River, 44 km from the east coast of Florida. Excavated during a salvage operation following commercial shell mining,  $^{14}\text{C}$  dates of charcoal place Harris Creek within the Florida Middle Archaic Period (5000-6000 B.P.).

Analysis of the faunal remains yielded marine species such as conch, whelk, and heron suggesting a link to the coast via trade or travel. Carbon isotopic ( $^{13}\text{C}/^{12}\text{C}$ ) analysis revealed that 90% of the sample ( $n=50$ ) largely subsisted on freshwater and terrestrial resources; however, outliers in the sample suggest some individuals may have had a marine dietary component. Strontium isotope analysis offers a method to directly track human movement from coastal regions that can then be compared with the exchange of goods.

Individuals that occupied coastal areas during subadult years are readily contrasted from those that lived inland due to the variable  $^{87}\text{Sr}/^{86}\text{Sr}$  values in each region as recorded in tooth enamel. Harris Creek has lower  $^{87}\text{Sr}/^{86}\text{Sr}$  values than Florida coastal regions due to the age and lithology of the bedrock and overlying sediments; coastal regions have  $^{87}\text{Sr}/^{86}\text{Sr}$  values of modern seawater. Harris Creek individuals with enamel  $^{87}\text{Sr}/^{86}\text{Sr}$  values similar to those of coastal regions are interpreted as immigrants.

Mosaic evolution and modern human origins: The picture from the Levant. C.B. QUINTYN, Department of Anthropology, University of Michigan, Ann Arbor, MI 48109.

In the arguments on modern human origins, the Qafzeh and Skhul hominids, based on skeletal analyses, are lumped as a group and labeled "Proto-Cro-Magnons." For many years this label has governed perceptions, leading many to assume that (1) the Qafzeh and Skhul hominids are the first Cro-Magnons, and (2) the Qafzeh and Skhul hominids are a "single" variable sample.

In this research, 40 dimensions were measured on the crania of Qafzeh, Skhul, Cro-Magnons, Neanderthals and other archaic, early, and recent modern samples from Africa, Western Asia, Europe, and East Asia (total crania,  $N=400$ ). Canonical variable analysis based on log size/shape and log shape D2 and typicality probabilities show quite clearly that the Qafzeh and Skhul hominid samples are distant from the Cro-Magnons (log size/shape and log shape probabilities, 0.0001) and different from each other. Qafzeh and Skhul are closer morphometrically to African and Levantine sample groups. Specifically, analysis of female cranial and facial variables shows that Qafzeh 9 is closer by log size/shape typicality probabilities to the African samples Ngorongoro and Mumba 2 (0.6422 and 0.5000) and the Levantine sample Qid (0.5000) than to any other individuals. In contrast, Qafzeh 9's tooth size is within the archaic modern range. For males, analysis of cranial variables shows that Qafzeh 6 and Skhul 4 have strong morphometric similarities to several archaic modern samples. Skhul 5 and 9 are consistently distant from all sample groups in this research. In analysis of the facial variables, Qafzeh 6 and Skhul 4 are closest by log size/shape and log shape typicality probabilities to Jebel Irhoud 1 (0.5000 and 0.6000) and by log size/shape to Ohalo 1 (0.5423). Hierarchical cluster analysis presented similar results.

Based on the data in this research, the Qafzeh and Skhul hominids are not "Proto-Cro-Magnons." Instead, the data indicate that Qafzeh and Skhul have strong morphometric affinities to archaic and early modern Africans and Levantines. Together, the Qafzeh and Skhul skeletal samples shows strong evidence of mosaic evolution.

A preliminary molecular phylogeny of the guenons. R.L. RAAUM, T.R. DISOTELL, C.J. JOLLY, D.W. WILDMAN, P.T. TELFER, Department of Anthropology, New York University, NY, NY 10003 / NYCEP (New York Consortium in Evolutionary Primatology)

Guenons (Tribe Cercopithecini) comprise a diverse group of geographically widespread African primates whose evolutionary history is poorly

understood. Not only is the species level taxonomy variable, with 21 to 28 recognized species, the generic level taxonomy also incites debate, with 3 to 5 recognized genera. We chose 7 species representative of the diversity of the guenons for this preliminary analysis: two primarily non-forest guenons, *Cercopithecus aethiops* and *Erythrocebus patas*, three forest guenons, *C. albogularis*, *C. ascanius*, and *C. neglectus* (representing three different species groups), and two proposed basal guenons, *Allenopithecus nigroviridis* and *Miopithecus talapoin*.

We analyzed mitochondrial DNA sequences from multiple loci in these taxa utilizing both parsimony and maximum likelihood based methods. Our results call into question the recently resurrected genus name of *Chlorocebus* for the *aethiops* group. Furthermore, within the Cercopithecinae as a whole, we find three distinct clades: the papionins as traditionally understood, a clade containing *A. nigroviridis* and *M. talapoin*, and a clade containing the rest of the guenons. Due to long branch length phenomena, the relations among these three clades are unresolved. Under parsimony – regardless of weighting scheme – *A. nigroviridis* and *M. talapoin* invariably appear as basal cercopithecines. However, under maximum likelihood, they invariably appear as basal guenons. Support for CJJ's sample collection was provided by the MRC (Medical Research Council); support for labwork was provided by NSF Grant #9506892 to TRD.

Definition of the "lateral recess" and cranial pneumatization in the Catarrhini. T.C. RAE<sup>1</sup> and T. KOPPE<sup>2</sup>, 1. Evol. Anthro. Research Group, Dept. of Anthropology, Univ. of Durham, 43 Old Elvet, Durham DH1 3HN, UK, 2. Institut für Anatomie, Ernst-Moritz-Arndt-Universität Greifswald, Friedrich-Loeffler-Str. 23 c, D-17487 Greifswald, Germany

Previous studies of the paranasal sinuses in catarrhines have been complicated somewhat, particularly in cercopithecoids, by various references to a structure termed the "lateral recess" (LR), linked implicitly to the maxillary sinus. This structure has been referred to in passing in studies of anthropoid cranial pneumatization, but never properly defined. Perusal of the literature also suggests that two different areas in the nasal cavity are implicated by LR: one situated below the inferior nasal concha (LR1), and another above (LR2).

To evaluate the relevance of the LR in primate cranial pneumatization, extant and extinct adult

crania of catarrhines were examined using CT imaging. The structure and location of the LR were noted, along with the associated bony structures. These data were compared with descriptions of the LR and maxillary sinus.

The results suggest that LR1 may have little to do with the maxillary sinus *per se*. Since the definition of the sinus derives from the position of the ostium (hiatus semilunaris) in the middle meatus, above the inferior nasal concha, LR1 cannot be strictly homologous with the maxillary sinus. This "structure" is most likely an epiphenomenon of a large canine root inserted into a sinus-less nasal cavity. LR2 shares the anatomical relationship of opening into the middle meatus with the maxillary sinus, but may also be a structural consequence of facial architecture, rather than a pneumatization *sensu stricto*.

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A re-examination of intra-site craniometric variation at the Larson site, Walworth County, South Dakota. C.A. RAEMSCH, Hartgen Archeological Associates, Inc., Troy, NY 12180.

Interpretations of the Larson Site, Walworth County, South Dakota (AD 1679-1733) have been modified based on the re-examination of both cultural and skeletal data. This research addresses whether further re-interpretation of Larson social organization and interaction with neighboring groups is warranted. Ethnohistoric documentation and previous studies of late 17th to early 18th century Arikara social organization indicated an endogamous, matrilineal occupation at Larson. Craniometric data within the sample is thus expected to reflect relative genetic homogeneity overall, and less variability among females than among males. This research evaluates the validity of this assumption through an analysis of intrasample craniometric variability and through applying a population genetic approach for interpreting patterns of intrasite variation. The magnitude of biological variability within the Larson skeletal sample is judged relative to that found within skeletal samples of known biological composition, and to other Arikara samples. The determinant of the variance-covariance matrix for each sample is used as a measure of intrasample variability, and a bootstrap procedure is used to determine the significance of any noted differences among the samples. Patterns of variation defined by this analysis contradict previous assumptions regarding group interaction at Larson, and necessitate a re-examination of the site and of assumptions used in studying the social organization of past populations.

Three-dimensional loading and growth of the zygomatic arch: Pigs versus macaques. K.L. RAFFERTY and S.W. HERRING, Orthodontics, University of Washington, Seattle WA 98195

The zygomatic arch is among the best studied of the bones of the craniofacial complex in terms of *in vivo* biomechanics. However, because only the outer, lateral surface has been examined, its three-dimensional loading is still a matter of debate. For example, the squamosal bone of both pigs and macaques exhibits principal tensile strain in the posterosuperior direction (Herring et al., 1996; Hylander and Johnson, 1997), but it is not clear whether this pattern arises from torsion or out-of-plane bending. Using young miniature swine, we have for the first time recorded strains from both the medial and lateral aspects of the squamosal bone during mastication and masseter muscle stimulation. Double fluorochrome labels were used to access growth and morphology in the zygomatic arch of the same animals.

Strain data clearly indicated that while the lateral surface of the pig squamosal is primarily tensed, its medial surface is compressed. Thus, this bone is bent out-of-plane. Torsion was present but secondary. However, torsion may be more important in the macaque squamosal, which differs in shape and degree of shear strain. Growth results in the pig indicated approximately a threefold greater rate of subperiosteal deposition on the lateral surface of the squamosal bone than the zygomatic. This difference in growth rate is attributed to the presence of sutures that contribute to the lateral displacement of the zygomatic bone but not the squamosal. This explanation does not exclude the possibility that the rapid apposition on the lateral squamosal surface is regulated by the high surface strains that result from out-of-plane bending.

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Application of a predictive model of segment inertial properties to the study of primate quadrupedalism. D.A. Raichlen, Department of Anthropology, The University of Texas at Austin, Austin, Tx 78712

It has been suggested that pendular motion is an important energy saving mechanism during swing phase of quadrupedalism. One aspect of interest in this use of pendular motion is the relationship between the forelimb and hindlimb natural pendular periods (NPP). Meyers and Steudel (1997) found that in *Canis familiaris*, and in mammals in general, fore- and hindlimb NPPs tend to converge. More detailed analysis of how primates fit into this pattern is warranted due to differences in limb mass distribution between primates and other mammals. In this study, the NPP of several *Papio cynocephalus* individuals (from the Southwest Foundation for Biomedical Research) were calculated using a predictive model based on external limb measurements. The use of live primates allows for

future comparison of modeled NPP to the periods of limb oscillation used during actual gait.

Crompton, et al. (1996) created a geometric model of body segments using columns with either an elliptical or circular cross section. The shape of the column depends on two curves (one curve each to describe how the major and minor axes change with length). In this model, the minor axis of the ellipse varies with the major axis by a constant. The present study uses the same general shape, yet allows the major and minor axes to vary independently. The shape of each segment can then be determined by measuring the major and minor axis at three positions on the segment. Together with the length of the segment, these measurements allow a prediction of the segment's inertial properties.

Results, based on the modeled limbs, show that *Papio cynocephalus* follows the general mammalian pattern of fore- and hindlimb NPP convergence. This result was somewhat unexpected, since the distance from the pivot to the c.o.m. in the fore- and hindlimbs is different (in *Canis*, this distance in each limb is equal). The modeled limbs highlight the impact of the radius of gyration on the NPP. Differences in the distance of the c.o.m. from the pivot can be compensated for by the relationship between a limb's moment of inertia and its mass. It is plausible that this relationship allowed quadrupedal primates to increase distal musculature for greater grasping ability, while keeping fore- and hindlimb NPPs similar and within the range of quadrupedal mammals.

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Can histological age estimation methods be applied to sub-adults?: a study from Paloma, Peru. H.L. RAMSAY, Dept. of Anthropology, University of Missouri-Columbia, Columbia, MO 65211.

Previous research in bone histology has found a positive correlation between osteon population density (OPD) and osteological age in adults. However, the equations derived for histological age estimation contain very few or no sub-adults in their sample. If age estimate regressions are applicable in sub-adult samples there should be no significant difference between the histological and osteological age estimates. This study compares the histological and osteological age estimates of a sub-adult sample from Paloma, Peru (5,300 to 6,500 B.P.) to determine if a positive correlation between OPD and osteological age exists in sub-adults.

Cross sections were removed from the 6<sup>th</sup> rib of fifteen sub-adult skeletons excavated from Paloma. The cross sections were imbedded in plastic, thick sectioned, and histologically prepared. Osteon counts were recorded and histological ages were calculated for each of the individuals using the predicting formula of Stout and Paine (1991). The histological age estimates were then compared to the osteological age estimates using a paired t-test.

Histological age estimates for the Paloma sample were significantly different than the osteological age estimates. A regression of OPD to osteological age found no positive correlation. These results show that there is no discernible relationship between age and OPD for sub-adults. The lack of a positive correlation in sub-adults may be attributable to



cortical drift and the nature of growth and development in this age group.

While this study indicates that histological age estimates are not applicable in sub-adults to establish the age at time of death, it does not preclude histology as a research tool in juvenile bone. The use of histomorphometry to calculate remodeling rates in sub-adults could further our understanding of cortical drift and remodeling during growth.

Political economy of fertility and population growth among enslaved Africans in colonial New York. L.M. RANKIN-HILL, University of Oklahoma, Norman, OK 73019, M.L. BLAKEY, S.H.H. CARRINGTON, and J.E. HOWSON, Howard University, Box 987, Washington, DC 20059.

New York's African Burial Ground is an 18th century cemetery for enslaved Africans, of which more than 400 skeletal remains have undergone extensive study. An interpretation of historical fertility data in the bioarchaeological context is reported, here.

New York City municipal census data for the 18th century indicate the virtual absence of natural increase in the City's African population prior to the American Revolution. Natural increase among Europeans was slow but evident during the same period. These trends run contrary to predictions based on the sex ratios in the two populations. A host of stressors rooted in the political and economic circumstances of slavery in colonial New York appear to have placed strong limits on African fertility despite the large proportion of enslaved females brought to the colony.

Mortality was clearly high for women of reproductive age, notably for adolescent girls and young women, and possibly for female children, thus eliminating much of the fecundity of this community. Skeletal evidence of arduous work and active and chronic infectious disease stresses in women of reproductive ages suggests further limits on the fecundity of surviving women. Infant mortality is approximately 18% of all mortality in the African Burial Ground population, most of which occurs during neonatal life, with an obvious negative impact on natural population increase.

Historical chronicles also demonstrate that European enslavers in the more urbanized core of New York, frowned upon childbearing among their enslaved women workers. British government debate on the high death rate of African infants throughout its colonies may also be relevant to conditions in New York. Conditions more conducive to fertility later developed in connection with laws ending the legal transatlantic slave trade which reduced the foreign supply of human captives.

Brain/body relationships in New and Old World monkeys and apes. J.C. REDMOND and A. SANSONE, Department of Anthropology, University at Albany, SUNY, NY 12222.

Recent reports in the neurosciences underscore the differences between the brains of men and women in gross volume adjusted for body size. Few studies, however, have explored these relationships in nonhuman primates. This study quantifies sex differences for collected and published data in gross brain size and body mass in several genera of sexually and non-sexually dimorphic New and Old World monkeys and apes.

Least squares and multiple regressions were performed for *Cebus* (n=77; m=45, f=32), *Aotus* (n=71; m=40, f=31), *Presbytis* (n=69; m=28, f=41), *Papio* (n=117; m=53, f=64), *Hylobates* (n=100; m=51, f=49), and *Pan* (n= 120; m=59, f=61). Least square regressions of body weight to brain size were significant within each sex for *Presbytis*, *Papio*, *Hylobates*, and *Pan*. Slopes for male and female regressions for each of these genera did not differ significantly. Multiple regression analyses indicated that in addition to body weight, sex was a significant predictor of brain size in *Aotus*, *Presbytis*, *Papio*, and *Pan*. Therefore, a model positing a common slope and different intercepts for the two sexes was the best fit for these genera. However, for *Hylobates*, sex was not a significant predictor of brain size and body weight alone provided a better model fit.

Our results indicate that while brain volume is greater on average in adult males than adult females of the same body mass in several genera that are sexually dimorphic in body mass (i.e., *Presbytis*, *Papio* and *Pan*), brain size sexual dimorphism occurred in only one of our non-sexually dimorphic (for body size) genera (i.e. *Aotus*). Therefore, body size dimorphism may not account for the absolute brain size sex differences observed in some genera of primates.

Food object manipulation by chimpanzees in Mahale Mountains National Park. S REECE & MW MARZKE, Department of Anthropology, Arizona State University, Tempe, AZ 85287-2402 LF MARCHANT<sup>1</sup> & WC MCGREW<sup>1,2</sup>, Departments of Anthropology<sup>1</sup> and Zoology<sup>2</sup>, Miami University, Oxford, OH 45056

Studies of chimpanzee (*Pan troglodytes*) manipulation in standard laboratory situations are constrained by limited space, lack of natural objects and artificial substrates. When the captive setting is made more naturalistic, the grip

repertoire increases in variety. We used videotapes of wild chimpanzees to see if an even broader range of hand grips was used during manipulation of food objects in a natural setting. The apes were videotaped in the Mahale Mountains National Park, Tanzania. Forty-four individuals of both sexes and all ages were sampled opportunistically from close range. Ethograms wild and captive studies of manipulation were consulted and expanded, in order to analyze the tapes. Relative force of the grip was judged by the observers to be high or low depending on resistance to the grip from the teeth, branch, or other object.

Subjects used a large diversity of grips for handling small and large food objects. Manipulation of large fruit (> 7.5 cm diameter) elicited the largest variety of grips for both males and females, while ant fishing elicited the least, usually involving only the index finger and thumb. Much dexterity was seen during simultaneous but differential use of the radial and ulnar parts of the hand for holding and manipulation in food processing. High relative force occurred most often with an extended transverse hook grip and sometimes involved squeezing the object between the first and second metacarpals while it was being pulled away from the mouth. This type of grip is novel and was added to the ethogram during the study. We also identified a forceful grip that utilized distinctive features on the radial side of the chimpanzee hand to pinch fruit strongly while keeping the surface exposed for biting.

These new observations raise questions about the kinematics and kinetics of chimpanzee hand use that will be further explored with the video tapes and will also be addressed using laboratory studies.

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**Defining chronological growth standards for known fractions of tooth crown height in primate anterior teeth.**  
DJ REID, University of Newcastle, S HILLSON, Institute of Archaeology, University College London and MC DEAN, Department of Anatomy, University College London.

Studies on enamel hypoplasia have used simple fractions of crown height to estimate the age at which tooth formation was interrupted by illness. This approach usually takes no account of the time of initiation of tooth mineralization, or the hidden cuspal increments of enamel formed beneath the incisal edge or cusp tip. With regard to the lateral increments of enamel forming the crown surface, it also does not acknowledge that equal fractions of visible crown height might take unequal times to form. The present study develops standards for use in comparative studies, using histological sections of anterior teeth from modern humans, great apes and monkeys. For each tooth type in each taxon, the lateral enamel of the crown surface was divided into four equal quartiles of visible crown height, measured from the cement-enamel junction to the cusp tip or incisal edge along the labial midline. Counts of incremental structures were used to estimate formation times for cuspal enamel, and the times taken to form each quartile of crown height.

Cuspal enamel formation times varied in relation to enamel thickness, ranging between 0.6 years and 1.0 years among the different teeth types and primates. The time taken to form the crown height quartiles showed a distinct pattern. In human anterior teeth and in those of great ape incisors, the time taken to form each quartile, expressed as a proportion of the time taken to form the full crown height, showed a consistent decrease from occlusal quartile to cervical quartile – c. 15%, 19%, 29% and 37%. This pattern remained relatively constant for all tooth types. Other primates studied (e.g. mangabeys) formed each quartile of crown height in near equal proportions. There appears to be clear differences in the rates at which anterior crown heights grow among primates. All attempts to provide an age for hypoplastic defects from their appearance on crown surfaces must be based on prior histological analysis of individual primates. In spite of the relative constancy of the pattern of crown height formation, when quartiles are expressed as a percentage of the total time taken to form the crown surface, caution is still needed when estimating an absolute age at which defects were initiated.

**A disadvantage of being human: Poor posterior protection of the airway.**

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The morphology of the aerodigestive region has been shown to be a key determinant of an animal's breathing, swallowing, olfactory, and vocalizing abilities. Studies have previously focused on features such as laryngeal position in the neck or anterior laryngeal structure (e.g., epiglottis) in relation to palatal position, particularly concerning airway protection during swallowing. The structure of the posterior aspect of the larynx, however, has not been addressed. This study compares laryngeal anatomy from 50 mammalian genera via imaging (e.g., CT, MRI, cineradiography) and/or dissection to assess differences in posterior laryngeal structure. Results indicate that in many mammals, the posterior larynx is elevated far above the level of the vocal folds (vocal cords), thus providing posterior protection of the airway from retrograde flow of material in the digestive tract. Ungulates, for example, have superiorly projecting arytenoid and corniculate cartilages that overlap with a horizontal fold of the posterior pharyngeal wall. This posterior "interlock" is reminiscent of the anterior epiglottic-soft palate contact. Retrograde flow (e.g., in rumination) is thus diverted laterally into the piriform sinuses, rather than superiorly over the larynx as in humans. Many aquatic mammals also exhibit posterior airway protection as an adaptation for underwater feeding and vocalizing. Indeed, toothed whales have developed the ability to close completely the laryngeal inlet from the pharynx by opposing the arytenoid and corniculate cartilages against the epiglottis. Unlike most mammals, humans have arytenoid and corniculate cartilages that are relatively short and do not provide a significant barrier posteriorly. In addition, the adult human larynx lies lower in the neck compared with other mammals. In this position, the laryngeal aditus is exposed to the pharynx and has become, in effect, a part of the anterior pharyngeal wall. This configuration alters both anterograde and retrograde flow of material, causing passage over the laryngeal opening rather than around it laterally in the piriform sinuses. The human airway is thus at particular risk of

posterior incursions, such as can occur during regurgitation or gastroesophageal reflux. Although airway protection is compromised, the structural and positional changes of the human larynx may be adaptations for oral respiration and/or speech production.

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**Population genetic models and modern human origins.** J.H. RELETHFORD, State University of New York College at Oneonta, Oneonta, NY 13820

Debate continues over replacement versus continuity as the mode of the origin of modern humans. Some analyses of the fossil record have found the average biological distances across time between recent modern samples and earlier African samples to be smaller than distances across time within a given region. This observation has been used to argue for a recent African origin and replacement of non-African archaic populations. Other studies have found evidence of the reverse for some traits, indicating a strong signal of continuity, thus supporting a multiregional interpretation. These studies seem at first glance to be contradictory, yet closer examination of population genetic models shows that both observations are consistent with a multiregional model.

Computer simulation of neutral traits was used to examine biological distances over time under a simple model of a larger core population interacting with a smaller peripheral population. The model incorporates gene flow, genetic drift, and mutation. The simulated data were used to compare genetic distances across a span of 4,000 generations (roughly to 100,000 years). The results show that average genetic distances across time do not show continuity, but mimic the pattern expected under replacement. Because of drift, some loci do show continuity, although most loci do not. Multiregional evolution predicts that some (but not most or all) traits will show continuity, which is in agreement with studies of the fossil record.

The expected patterns under the multiregional simulation are in agreement with observations made in several recent studies of biological distance and prevalence of continuity, despite the fact that these studies are frequently cited as support for a replacement model. Closer examination shows differences in expected values that can be used for comparison and testing with the fossil record. The critical difference is in temporal changes in continuity. Under a multiregional model the prevalence of continuity decreases over time, whereas a replacement model with relatively high mutation rates will lead to a slower increase in continuity over time.

**Gorillas as gourmands: digestive capabilities and food preferences of gorillas.** M.J. REMIS, Sociology and Anthropology, Purdue University, W. Lafayette, IN 47907-1365.

The body size of gorillas is believed to facilitate consumption of high fiber foods and dietary flexibility

within and between subspecies. Gorillas at Bai Hokou, Central African Republic consume high fiber fruits and herbs in times of scarcity. During these periods, gorillas, chimpanzees and mangabeys may consume moderate to high concentrations of tannins in unripe fruits. In this study, captive gut passage trials were conducted on 6 gorillas housed at the San Francisco Zoo (SFZ). Additional paired-choice food preference trials were conducted on both the gorillas and 4 chimpanzees under plentiful food conditions at the SFZ. These studies provide us with additional information about the digestive strategies of gorillas and food preferences that may relate to ecological niches of the African apes. During gut passage trials, individual gorillas were fed 4 trials of 20 colored plastic markers (4 mm x 2 mm x 1 mm) concealed in bananas. Timing of defecations was recorded, and fecal material was screened for markers for 136 hours. Adult gorillas had a mean gut transit time of 25.9 hours, and mean gut retention time of 50 hours. During separate paired-choice captive food trials, each subject was presented with at least 10 replicates of all possible paired combinations of 9 foods that varied in sugar, fiber and tannin content (n=2478 paired choices). Foods were ranked according to preference. Gorillas and chimpanzees both demonstrated a preference for sugary, low fiber foods. Tannins were tolerated if presented in a sugary, easy to process package. Gorillas appear to have long gut retention times, relative to smaller chimpanzees. Ecological niche separation of gorillas and chimpanzees during fruit scarcity is facilitated by differences in body size and digestive strategies, but ecological overlap is common whenever mutually preferred ripe, fleshy fruits are available, whether in a zoo or natural setting.

**New directions in bioarchaeology, post-NAGPRA and the use of *Standardized Osteological Database*.** B. RENFRO, Environmental Dynamics, University of Arkansas at Fayetteville, AR 72701.

The period prior to the passage of the Native American Graves Protection and Repatriation Act was one of uncertainty for most individuals who studied human skeletal remains in the United States. It was from the threat of repatriation and the loss of osteological data that *Standards For Data Collection From Human Skeletal Remains* (Buikstra and Ubelaker 1994) and *Standardized Osteological Database* (Harris and Rose 1995) were created. Both were adopted as protocol for meeting NAGPRA compliance inventories by all institutions that house Native American skeletons and receive federal funds. With the initial phase of the inventory process completed the availability of osteological data in a comparable format has ushered in a new

avenue of research for bioarchaeologists.

This paper outlines the historical aspects of the development of SOD; its technical specifications, and methodological approaches for its use in data analysis. It reviews such functions as importing and exporting data, database table structures, report functions, output options, and the use of Systems Query Language (SQL) in writing user defined queries. It also discusses the shortcomings of the program due to its outdated format. In summation it offers suggestions for the use of osteological data in a digital format in the perspective of this new avenue of research in bioarchaeology.

A preliminary assessment of the effect of muscle-specific stress on the cross-sectional geometry of the humerus among the prehistoric agriculturalists of Arroyo Hondo Pueblo. M.L. RHOADS, M.A. SCHILLACI, E.A. CARSON, E.G. OZOLINS, Department of Anthropology, University of New Mexico, 87131.

Activity-related musculoskeletal stress markers (MSM) have been used convincingly to study habitual activity patterns of prehistoric populations (Hawkey and Merbs, 1995). The use of MSM for analyzing the effects of specific muscles on aspects of longbone cross-sectional geometry, however, has not received much attention in the literature. In our preliminary study we investigate the relationship between the activity-related MSM of six upper limb muscles and the mechanically relevant cross-sectional properties of the humerus in a sample of prehistoric agriculturalists from Arroyo Hondo Pueblo (AD 1300-1425) in northern New Mexico.

MSM for *pectoralis major*, *brachialis*, *biceps brachii*, *coracobrachialis*, *teres major*, *deltoideus*, *triceps brachii*, and *latissimus dorsi* were ranked from the most to least expressed for each muscle at its insertion point. Although this method does not allow for comparisons with other skeletal samples, we were able to discern small differences between individuals while reducing inter- and intra-observer error.

Humeri were cross-sectioned via CT scans at 65% of biomechanical length (Ruff and Hayes, 1983) and were also measured for their mesio-lateral and antero-posterior diameters. The CT generated cross-sectional images were then digitized using SLICE (Nagurka and Hayes, 1970). Ranked values for cortical area and maximum second moments of area ( $I_{max}$ ) were then compared with the ranked MSM scores of each muscle and with the average rank over all muscles for each humerus.

Preliminary, the results of our analysis indicate there is only a weak relationship between MSM and mechanically relevant aspects of humeral cross-sectional geometry.

This research was supported by the School of American Research.

Early hominin limb proportions: Is 'Lucy' significantly different from her 'Children'? B.G. RICHMOND<sup>1</sup>, L.C. AIELLO<sup>2</sup> & B.A. WOOD<sup>1</sup>, (1) Dept. Anthropology, George Washington University, Washington, D.C. 20052, (2) Dept. Anthropology, University College London, England WC1E 6BT.

Recent analyses and new fossil discoveries show that the evolution of hominin limb proportions is surprisingly complex. It has been argued that the humerofemoral (HF) proportions of the *Homo habilis* skeleton OH62 are more apelike than those of the partial skeleton AL288-1 of *Australopithecus afarensis*. The recently-discovered partial skeleton BOU-VP-12/1 from Bouri, possibly representing *A. garhi*, reportedly exhibits a humanlike HF index combined with an apelike brachial index, while *H. ergaster* (KNM-WT 15000) is humanlike in both. Although there is little doubt that most of these individuals had different limb proportions, this study tests the hypothesis that these differences exceed those observed within extant species.

Lengths and midshaft dimensions were measured on the humerus, radius, and femur of mixed subspecies of *Gorilla gorilla* (n=50), *Pan troglodytes* (n=34), *Pongo pygmaeus* (n=30), and mixed populations of *Homo sapiens* (n=50). Published measurements and length estimates were used for the fossils. Using an exact randomization approach, the difference in proportions between fossil pairs was compared to the differences between all possible pairs of individuals in each extant species (e.g., 1225 pairs in a sample of 50 gorillas) to assess the probability that such a difference could be sampled in a single species.

The magnitude of HF index difference between OH62 and AL288-1 does not exceed variation in the great apes, but it is rare (P<05). However, just a slight change in length estimates would render the difference insignificant. In most direct comparisons of upper to lower limb measures (e.g., humeral:femoral circumference), the difference between OH62 and AL288-1 is not uncommon in extant species. The HF index of BOU-VP-12/1 differs significantly from both OH62 and AL288-1, but not from KNM-WT 15000. Published length estimates suggest that the relative forearm length of BOU-VP-12/1 is unique among hominins, exceeding that of the African apes and resembling *Pongo*.

Supported by The Henry Luce Foundation.

Comparison of longitudinal, cross-sectional, and mixed longitudinal data in growth analysis. J.T. RICHTSMEIER, T.M. COLE, C.J. VALERI, T. KONTIS, The Johns Hopkins University School of Medicine, Baltimore, MD 21205.

The study of growth has a long history in biological anthropology and can provide information pertaining to evolution, adaptation, speciation and disease. Due to the scarcity of longitudinal data, growth analyses are often conducted using cross-sectional data. Because individual variability is known to occur in growth patterns, and because true growth data are dependent data (each data point dependent upon that which precedes it in time), some investigators have proposed that the only data appropriate to the study of growth are longitudinal data. We set out to test the hypothesis that results obtained from analysis of longitudinal data are



inconsistent with those obtained from cross-sectional data in the study of growth patterns.

Ten weaned New Zealand White rabbits (*Oryctolagus cuniculus*) were obtained at 5 weeks of age and housed under approved, normal laboratory conditions. After a two-week acclimatization period, computed tomography (CT) images were acquired for each rabbit at 7, 9, 11, 13, and 15 weeks of age. Landmark coordinate data were collected from 3D reconstructions of the CT image data and used in a morphometric study of cranial base growth of the New Zealand White rabbit. Euclidean Distance Matrix Analysis (EDMA) was used to quantify growth patterns i) for each individual rabbit, ii) for mean forms made up of all longitudinal data, and iii) for mean forms constructed to mimic cross-sectional and mixed longitudinal data sets.

We found similarity in the patterns (but not necessarily magnitudes) of growth between individuals and mean forms using all longitudinal rabbit data. However, growth patterns calculated from purely cross-sectional samples of randomly chosen individuals showed differences when compared to growth patterns derived using the full longitudinal data set. Mixed longitudinal data (even those samples with only two individuals shared between consecutive age groups) showed a closer fit with the longitudinal data in terms of overall pattern of growth. In our sample of 10 individuals, strict cross-sectional data did not always reflect the results of longitudinal data analyses. Longitudinal data points, when available, should be used with existing cross-sectional data.

Supported by grants from Johns Hopkins University (TK) and National Institute of Dental and Craniofacial Research (JTR).

A comparative PET study of linguistic processing in humans and language-competent chimpanzees. J. RILLING<sup>4</sup>, C. KILTS<sup>2,4</sup>, S. WILLIAMS<sup>1</sup>, M. BERAN<sup>1</sup>, M. GIROUX<sup>2</sup>, J.M. HOFFMAN<sup>2,5</sup>, S. RAPOPORT<sup>3</sup>, S. SAVAGE-RUMBAUGH<sup>1</sup>, and D. RUMBAUGH<sup>1</sup>.  
<sup>1</sup>Language Research Center, Georgia State Univ., <sup>2</sup>Emory Center for PET, <sup>3</sup>National Institutes on Aging, Depts. of <sup>4</sup>Psychiatry and <sup>5</sup>Radiology, Emory Univ., Atlanta, GA, 30322.

The objective of this study was to use Positron Emission Tomography (PET) to determine if humans and language competent chimpanzees recruit homologous neural substrates when processing linguistic stimuli, and thereby provide insights into brain evolution relevant to the emergence of modern human language. Following an intramuscular injection of <sup>18</sup>F-FDG (10 mCi), two adult female chimpanzees ("Panzee" and "Lana") performed computerized speech and symbol comprehension tasks during the 40 minute period of tracer uptake into the brain. After the task, subjects were anesthetized with ketamine and 2% isoflurane and scanned in a Siemens 951 PET tomograph. Replicate scans were acquired from each chimp and both were scanned following a sensorimotor control task. Two human subjects received H<sub>2</sub><sup>15</sup>O PET scans while performing the same tasks. Prior to statistical analyses, all scans were spatially registered to an anatomical MRI.

In humans, the speech - control contrast revealed left lateralized activation in Heschel's gyrus, the planum polare, and frontal cortical areas ( $t > 1.5$ ). Homologous areas were not activated in the chimpanzee for the same contrast;

Panzee activated bilateral dorsomedial frontal cortex, cerebellum and thalamus. Our results suggest that "Panzee" processes language using different brain regions than do our human subjects, and perhaps that the neural substrate which supports linguistic processing in modern humans uniquely evolved in the hominid lineage. Further studies are needed to address the following three issues: 1) do the results for Panzee generalize to other language-competent chimpanzees, 2) do the receptive language areas of the chimpanzee and human brain exhibit a greater homology for their respective species-specific communication behaviors (e.g., calls, gestures, and facial expressions), 3) does the more closely related bonobo exhibit a closer homology to human language areas. Supported by NICHD grant 06016 and Georgia State University College of Arts and Sciences.

Innominate and femora revisited: ridges and buttressing - what do they mean? C.A. ROBERTS, Department of Archaeology, University of Durham, Science Site, South Road, Durham, DH1 3LE, U.K.

In recent years observations of distinct raised ridges of bone on innominates in British archaeologically derived skeletal material have been made (Roberts, 1987). The ridges extend from just below the anterior-superior iliac spine on the lateral surface of the innominate to just above the rim of the acetabulum. It does not correspond with any muscle attachments, the inferior gluteal line or the area of occurrence of acetabulo-cristal buttresses (Rose, 1984). It was suggested (Roberts, 1987) that the ridges could be related to a pathological process, a biomechanical adaptation, or that it may be a non-metric trait. Raders and Peters (1993) suggested that the buttressing was developmental in origin and the result of behavioural influences.

This paper provides data on innominate ridges from a number of British medieval populations from different funerary contexts: urban hospital, rural settlement, and an urban monastic community. Initial work suggests that the males at the rural site have the highest frequencies of buttressing (27.6%), and that the rural sites have higher frequencies overall (21.5% as opposed to 4.1%). Additional data from hunter gatherer and agricultural groups from Kentucky suggest that males in the former were affected three times more than the females (16.7% and 5.1%), and from Nubia (agricultural), females had higher rates than males (14.3% and 8.7%). By considering funerary contextual data and other biological data for these sites, suggestions for the aetiology of these ridges will be made.

Rader, WT and Peters, CR 1993 Hypertrophy of the acetabulo-cristal buttress in *Homo sapiens*.

*Amer.J.Phys.Anthrop.* 92:149-153

Roberts, CA 1987 Bars of bone on hip bones in antiquity: pathological, occupational or genetic? *Human Evolution* 2(6):539-545

Rose, MD 1984 A hominine hip bone, KNM-ER 3228, from East lake Turkana. *Amer.J.Phys.Anthrop.* 371-378

**Mechanisms of female dispersal in a female-bonded species.** J.G. ROBINSON<sup>1</sup>, X. VALDERRAMA<sup>2</sup>, AND D.J. MELNICK<sup>2,3</sup>.

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As in most nonhuman primate species, wedge-capped capuchin monkeys (*Cebus olivaceus*) are characterized by male-biased dispersal and female philopatry. In turn, relatedness among group females may have promoted the evolution of female-female cooperation, particularly with respect to allomaternal care and aid in agonistic interactions. Field observations over twenty-one years have revealed that females have a strong role in controlling group size and structure.

Several mechanisms exist by which females may transfer out of their natal groups and thereby distribute genetic material across groups. First, entire matriline may splinter from a large group and form a new group ( $n=2$ ). Second, a matriline may splinter and fuse with an existing group ( $n=1$ ). Third, multiple pairs of related females may transfer and fuse simultaneously with an existing group ( $n=1$ ). Finally, an individual female may transfer alone to another group ( $n=4$ ). All four mechanisms seem to hinge on the transfer of at least one adult female. In addition, existing groups that accept females are always small groups. Studies of other nonhuman primate species have indicated that the transfer of related males to the same group may enhance survivorship and provide alliances in agonistic interactions. We propose that these same advantages may apply to the simultaneous transfer of related females as observed in wedge-capped capuchins. This research was supported by National Science Foundation grant 9908455 and the Wildlife Conservation Society.

The African origins of the South Carolina "Gullah"  
Reconsidered: An anthropometric analysis  
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Pollitzer's (1958, 1964) explorations of the Gullah-speaking population of South Carolina found them to be more closely related to West Africans than other African American populations. More recent research has focused on the question of the Gullah population's specific African ancestry. Genetic investigation of haplotypes associated with the sickle cell allele (Hb S) reflects the heterogeneity of the South Carolina population, indicating ancestral contributions from all areas of West Africa. Sickle cell patients in the contemporary population possess more Hb S alleles found along the Slave and Gold Coasts (Rogers et al., 1999). However, conclusions of ancestral origins based upon this system are tenuous due to the strong selection for the abnormal hemoglobin allele in West Africa and colonial South Carolina.

Anthropometric data collected by Pollitzer (1958)\*

was compared with published data from other West African groups using multivariate statistical methods. Differences between Gullah males ( $N = 54$ ) and those of Angola, Congo, Northern Nigeria, and Senegal were highly significant. Gullah males were most closely associated with males of the Kassai region of Congo, followed by Nigerian males. Differences between these three groups of males were non-significant. Highly significant differences in nasal and facial dimensions were found between Gullah females ( $N = 421$ ) and females of Congolese and Northern Nigerian populations. No significant differences were found between Gullah females and those of the Ouelle and Kassai regions of Congo or females of Nigeria and Angola. The canonical distribution shows Gullah females to be most closely associated with Nigerian and Angolan females.

\*Original data was provided by Dr. William S. Pollitzer

Walking, having babies and keeping warm: multiple selective pressures on human pelvic morphology. K.R. ROSENBERG, Department of Anthropology, University of Delaware, Newark, DE

The requirements of bipedal striding placed significant selective pressures and constraints on the form of the human pelvis throughout the Plio-Pleistocene. However, locomotion is not the only function served by this important morphological complex. The critical role that obstetrics plays in determining pelvic morphology was often overlooked in the analysis of human fossils until the last few decades. Because selection through childbirth acts directly on females and less directly on males, an analysis of the implications of this selective constraint requires intra-sex comparisons as well as an understanding of changes in sexual dimorphism. Similarly, climate is clearly an important selective determinant of body size, body shape and pelvic dimensions in humans. An understanding of that constraint in pelvic evolution requires attention to latitude of origin in the fossil record. The interaction among these different (and often competing) sources of selection has not only been influenced by, but has itself influenced the form of modern human gait.

In the last fifteen years, a number of hominid fossil discoveries have been made which provide information on the morphology of the pelvis. These include: Nariokotome, Kebara, Jinniushan, and Sima de los Huesos. These specimens span a range of geological time, a range of geographic origins (and climates) and include both males and females. In this study, I examine data from these newer specimens (as well as previously known fossils from Europe, the Near East and Africa) as a first step toward separating out the effects of these multiple sources of selection and identifying their interaction. This type of analysis demonstrates, for example, that aspects of archaic human pelvic morphology previously described as either adaptations to birth or derived traits unique to Neandertals are neither. Instead, the pattern of sexual dimorphism shows these features to be more marked in males than in females

and the pattern of geographic variation shows that this morphology existed in other archaic human populations and almost certainly represents the primitive hominid condition. It is only by considering non-locomotor adaptations of the human pelvis that we can hope to understand the emergence of modern human walking.

The hominoid glenohumeral joint and the question of climbing in *Australopithecus*. B.A. ROSENMAN, Department of Anthropology and Division of Biomedical Sciences, Kent State University, Kent OH 44242, and R.A. WALKER, Department of Anatomy, New York Chiropractic College, Seneca Falls, NY 13148.

Several investigators have proposed that the scapulae of *Australopithecus afarensis* and *Australopithecus africanus* show significant adaptations for climbing. The primary trait used to infer this conclusion has been the "bar-glenoid angle", which purportedly aligns *Australopithecus* more closely with the African apes than modern humans. However, the bar-glenoid angle appears not to be related to locomotor mode in any meaningful way. The current study presents detailed morphological and metric comparisons of the glenohumeral joint among *Homo sapiens* (N = 55), *Pongo pygmaeus* (N = 8), *Pan troglodytes* (N = 13), *Gorilla gorilla* (N = 13), and several australopithecine specimens: Sts 7, AL 288-1, AL 333-87, AL 333-107, AL 333-109, and KNM-BG 1745. Traits measured include the transverse and vertical diameters of the humeral head and glenoid fossa, the bar-glenoid and spinoglenoid angles of the scapula, and the torsion of the humeral head, as well as the ratio of glenoid area over humeral head area.

In contrast with some studies, our results indicate that the scapulae and proximal humeri of *Australopithecus* do not differ significantly from *Homo sapiens*. Non-metric similarities shared by the two taxa include the morphology of the glenoid fossa, infraglenoid tubercle, and intertubercular sulcus, as well as the shape and alignment of the long axis of the humeral head and orientation of the coracoid process. The bar-glenoid and spinoglenoid angles apparently group AL 288-1 with the apes. Closer inspection reveals, however, that AL 288-1 falls within the human range, as evidenced by the fact that small humans occasionally possess a bar-glenoid angle identical to AL 288-1 (Inouye and Shea, 1997, *Int. J. Primatol.* 18:629-650). Similar results are found with respect to the glenoid-humerus ratio, in which AL 288-1 and Sts 7 easily fall within one standard deviation of the human mean. Therefore, because the ranges of our results overlap in taxa of greatly disparate locomotor modes, claims for climbing in *Australopithecus* are unwarranted.

Platyrrhine paranasal sinus patterns: a preliminary investigation. J.B. ROSSIE, Dept. of Anthropology, Yale University, New Haven, CT 06520.

The New World Monkeys (NWM) offer a valuable body of data for paranasal

sinus (PNS) research. They comprise a large portion of the living genera of anthropoids and their apparent diversity in PNS patterns exceeds that seen in catarrhines (Hershkovitz, 1977). As the living outgroup to the catarrhines, their similarity to hominoids in both PNS patterns (Ward, 1997) and maxillary sinus/body size scaling relationships (Koppe et al., 1999) is of interest.

Despite this, only catarrhine sinuses have been well documented. The few studies of NWM PNS anatomy that exist disagree over the intergeneric homology of sinuses, particularly the frontal and sphenoid. Since the site of origin of a sinus determines its homology, the present study employed CT technology to identify sinus ostia in a small sample of NWM crania housed at the Yale Peabody Museum. At Yale-New Haven Hospital, the crania were serially CT scanned in the coronal plane at 1mm intervals. Three-dimensional images of the sinuses and nasal cavity were reconstructed using Scion Image software.

Results indicate that platyrrhines possess more elaborate PNS patterns than has recently been implied. Only when these patterns have been more completely documented, can phylogenetic and functional hypotheses be tested within this group.

**CT - guided biopsy - a new technique and its value for paleopathological examinations.** F.J. RUEHLI, Institute of Diagnostic Radiology, University Hospital, 8091 Zurich, J. HODLER and TH. BOENI, Orthopedic University Clinic Balgrist, 8008 Zurich, Switzerland.

The aim of this study is to demonstrate value and limits of computerized tomographic (CT) - guided biopsy as a new method in paleopathological research. The use of this technique is presented in a case of an ancient Egyptian mummy.

A mummy of an 8 year old boy from the collection of the „Museum für Völkerkunde“ in Burgdorf (Switzerland) underwent conventional X-rays and was later CT scanned. The examination revealed uncommon radiological findings of the spine. According to previous investigators in the 1920's these changes were supposed to be Pott's disease. For further bacterial DNA and histology analysis, it was decided to take samples from the bony and soft tissue. Biopsies were taken at the Orthopedic University Clinic Balgrist Zurich with a CT - guided (Siemens HiQ, Siemens, Erlangen, Germany; 3mm slice thickness, 3mm

table increments) 12.5cm / 2mm - Ostyicut bone biopsy needle.

Valuable human remains - like e.g. mummies with their original wrappings - are target objects of this new method. In comparison to conventional needle core biopsy a much better accuracy and improved explanation rate of unclear radiological findings can be expected. The real-time control of the actual needle position allows an optimal minimally invasive approach and, therefore, better handling of the fragile objects. In addition, results will also depend on experience of operator and location and size of target area. The approach with the shortest distance between biopsy area and skin (like the dorsal approach selected in this case) is recommended for less physical destruction and contamination. Consistency of mummified tissue differs from the one of fresh human cells, which makes it much more difficult to obtain samples especially when using instruments with small diameters.

Nevertheless, this technique will play a major role in further minimally invasive paleopathological examinations.

Lifeway changes as shown by postcranial skeletal robustness. C.B. RUFF, Dept. Cell Biology and Anatomy, Johns Hopkins Univ. Sch. Med., Baltimore, MD 21205, E. TRINKAUS, Dept. Anthropology, Washington Univ., St. Louis, MO 63130, and B. HOLT, Univ. Missouri, Columbia, MO 65211

Given their extreme developmental plasticity, long bone diaphyseal cross sections preserve a record of the mechanical loadings applied to them during life. Thus, they should reflect, in part, behavioral changes that occurred during human evolution. To identify behaviorally significant aspects of cross-sectional variation, it is first necessary to factor out the effects of body size on limb bone mechanical loadings. To avoid possible circular reasoning, estimates of body size should be derived using *nonmechanically* based methods. In this study, a morphometric approach, using estimated stature and measured or estimated bi-iliac breadth, was used to calculate body mass for a large (n=111) sample of Pleistocene and early Holocene *Homo* specimens with associated femoral midshaft cross-sectional diaphyseal data. The diaphyseal data were derived from measurements of naturally broken sections, and section contours reconstructed from external molds and multiple plane radiography. Several very recent (>1000 A.D.) samples from North America and East Africa were available for comparison. The two biomechanical section properties examined were cortical area (CA) and the polar section modulus (Zp). Mechanical predictions, supported by observations among recent populations, are that CA should scale with body mass, and Zp with the product of body mass and bone length. Residuals from reduced major axis regression lines through the very recent pooled sample were used to examine the relative femoral strength of the earlier specimens.

There is a significant decline in both relative strength indicators from the early Pleistocene through the early Holocene, although there is some suggestion of a leveling off in relative strength after 35,000 BP. Neandertals do not depart from this general trend, i.e., they are not outliers with respect to either broadly contemporary (Skhul-Qafzeh) or succeeding (Upper Paleolithic) samples. Specimens from all time periods are significantly stronger than those from the very recent sample (which is still pre-industrial).

These results imply a generalized reduction throughout the

Pleistocene in overall loading of the lower limb, relative to body size, which in turn implies a reduction in activity level and/or muscular strength. Other evidence from cross-sectional shape analyses indicates a continued reduction in mobility from the Upper Paleolithic through the Mesolithic. Another reduction in overall loading of the lower limb occurred later, between the Mesolithic and very recent times.

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**Detecting evolutionary novelties in the human genome.** M. RUVOLO, Department of Anthropology, Harvard University, Cambridge, MA 02138.

The human genome is a mosaic of anciently- and recently-derived features. One goal of a Human Genome Evolution Project would be to identify recently-derived features unique to the human genome and ultimately to characterize their functional properties. Of the roughly  $2 \times 10^9$  basepairs of non-repetitive (single copy) DNA in the human genome, two percent, or 40 million basepairs, differs from that of chimpanzee and bonobo genomes. This difference is distributed over exons, introns, and intergenic regions; therefore only a fraction of this genetic difference is responsible for the functional changes which uniquely characterize the human phenotype. Identifying the subset of functionally significant genetic changes which distinguish *Homo* from *Pan* will rely in part on using empirical evidence from other species and current hypotheses about what types of genetic changes bring about phenotypic change. Human genes that have been substantially remodeled in their coding sequences will be relatively easy to identify by molecular evolutionary parameters, while regulatory changes will be more difficult to characterize. Having cDNA libraries of expressed genes from different developmental stages and tissue types in *Pan* species (and from *Gorilla*) would be an invaluable resource for this project.

Quantitative analysis of trabecular bone structure in the femur of lorisoid primates using high resolution x-ray computed tomography. T. M. RYAN, Dept of Anthropology, The University of Texas at Austin, Austin, TX 78712-1086

It has been hypothesized for over a hundred years that trabecular bone plays an important structural role in the



musculoskeletal system of animals and that it dynamically responds to applied loads through growth. Despite this hypothesized importance, there has been very little work examining the structure and mechanics of trabecular bone. It has been only recently, with the advent of high resolution x-ray computed tomography (HRXCT) scanning, that the three-dimensional architecture of trabecular bone has been examined non-destructively. In this study the three-dimensional structure of trabecular bone in the proximal femur of several strepsirrhine primates is examined to determine the interspecific variation in the bony structure and its functional relationship to locomotor behavior.

The proximal femora of *Galago senegalensis*, *Otolemur crassicaudatus*, and *Perodicticus potto* were scanned using the HRXCT scanner at the University of Texas at Austin (<http://www.ctlab.geo.utexas.edu/>) using a 45  $\mu$ m slice thickness. Quantitative stereological analyses were conducted on these scan data to determine the structure and orientation of trabecular bone in the femoral head. Measured parameters include the bone volume fraction, trabecular plate number and thickness, and the structural anisotropy or orientation.

The results of this study suggest that there are some differences in the trabecular bone of the leaping and non-leaping taxa. The potto displays a higher bone volume fraction and thicker trabecular plates than the two galagid taxa. In addition, in transverse section, the trabeculae display a generally antero-posterior orientation in the galagids which contrasts sharply with the apparently more anisotropic arrangement in the potto in which the trabeculae do not display a preferred orientation.

Supported by grants from NSF and the College of Liberal Arts at the University of Texas at Austin.

**Project Silver: an ape genome project toward deciphering genetic changes responsible for creating humanness.** SAITOU N., KITANO T., LIU Y.-H., NODA R., and KOBAYAKAWA H. Lab. Evolutionary Genetics, Natl. Inst. Genetics, Mishima, 411-8540, Japan.

Nucleotide difference between human and chimpanzee, the closest living organism to human, is about 1.4%. Therefore, half (0.7%) of this difference accumulated after the human lineage diverged from the chimpanzee lineage. All the genetic changes responsible for "humanness" must reside in those differences.

Human genome consists of about 3 billion nucleotides, thus the 0.7% difference is tantamount to 21 million nucleotide changes. Although 95% (or more) of the human genome can be considered as junk DNA, we still have ~1 million nucleotide changes located in nonjunk DNA. How many changes are really responsible for creating humanness in those changes? Our very rough guess is only 10,000.

Draft human genome sequences will be completed within a year or so. It is now the time to sequence ape

genomes so as to compare them with human sequences nucleotide by nucleotide. Because we are interested in the changes which occurred in the human lineage, we should compare not only chimpanzee but also gorilla and orangutan. We can pinpoint human-specific changes only after multiply-aligned those ape and human sequences.

We just started this kind of sequencing "Ape genome" (Ag = silver) by picking up interesting part of the human genome sequences. PCR primers are made based on those sequences, and corresponding orthologous DNAs are amplified for apes, followed by direct sequencing.

The determined nucleotide sequences will be submitted to the DDBJ/EMBL/GenBank International Nucleotide Sequence Database, and will also be available through web site of this project, as follows:

<http://sayer.lab.nig.ac.jp/~silver/>

email: [nsaitou@genes.nig.ac.jp](mailto:nsaitou@genes.nig.ac.jp)

web: <http://sayer.lab.nig.ac.jp/>

**Taphonomic aspects of eagle predation of primates from Kibale Forest, Uganda.** W.J. SANDERS, Museum of Paleontology, University of Michigan, Ann Arbor, MI 48109, and J.C. MITANI, Department of Anthropology, University of Michigan, Ann Arbor, MI 48109.

Crowned eagles (*Stephanoaetus coronatus*) are large, powerfully built forest raptors which prey primarily on small-medium sized mammals as heavy as bushbuck (ca. 30 kg.). Our study focuses on the taphonomy of crowned eagle kills from Kibale National Park, Uganda. The sample consists of skeletal elements and hair boluses gathered from nest and kill sites of two eagle pairs, between July 1996 and August 1999. 345 specimens were collected from the first nesting pair, and 39 specimens from the second.

Attributes noted for each specimen include: element, side, taxon, age-sex class, dimensions, association, and damage. At Kibale, the primate fauna is diverse, with chimpanzees and seven species of cercopithecoids, and comprises a high percentage of the biomass. Accordingly, although crowned eagles have not taken chimpanzees at Kibale, primates are the predominant group in the collection. Small redtail monkeys (*Cercopithecus ascanius*) are the most commonly represented primate, but monkeys as large as adult grey-cheeked mangabeys (*Lophocebus albigena*) are also present. As well, material from kills of the first nesting pair indicates an increased emphasis on hunting larger black-and-white (*Colobus guereza*) and red (*Procolobus badius*) colobus monkeys during November 1998-August 1999. All age grades and both sexes of these species are represented in the sample. Analysis of sample material reveals clear patterns of bone survivability and damage that may be distinctive of eagle kills: hindlimb bones are preserved in greater numbers than other elements; long bone diaphyses are seldomly fractured, but their epiphyses, marrow and trabeculae may be removed; tails are often removed as a single unit; flat bones and crania have sharp talon punctures resembling "can-opener" perforations; mandibulae are usually undamaged; brains are extracted from adult crania by removal of the basicranium, while infant and juvenile crania are opened by pressure which separates individual bones at their sutures; scapular blades are raked and jagged towards their dorsal borders. The results are critical for assessing the impact of eagle predation on the behavior, population structure, and ecology of primate species at Kibale. They should also be useful for evaluating hypotheses of eagle

involvement in the predation of fossil primates (e.g., Taung).

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Population admixture in America: concepts, estimations, and the direction of gene flow. M.SANS, Dept. of Biological Anthropology, College of Humanities, Univ. de la Republica, Uruguay. B.BERTONI, Dept. of Genetics, College of Medicine, Univ. de la República, Uruguay, and P.C. HIDALGO, Instituto Superior de Ciencias Médicas de Villa Clara, Cuba.

American populations are conformed by the unequal contributions of Native American, European, and African people. In this study, we analyze those contributions for most of the American countries and regions, based on blood groups and protein systems, nDNA, mtDNA, and Y-chromosome data. In the first essay, we review values of population contributions using different authors' estimations; in a second essay, we reconsider admixture using the same genetic systems and methods for every population, and in a third essay, we analyze isolated populations (African or Native descendants), as well as ethnically-defined groups ("Mestizo", "Indios", "Hispanic", "Afro-American"), and we examine the different contributions inside them. Finally, we analyze paternal (Y-chromosome) and maternal (mtDNA) contributions when possible. In every case, heterozygosity and fixation indexes are analyzed, and maps, dendrograms, and networks, were performed.

Clines and values are discussed, based on classical models that divide the continent in Euro-, Afro-, and Native-America. Also, we discuss the criteria that classify the ethnically-defined groups, according to the geographic region, and the admixture contributions. Finally, we discuss the direction of gene flow in the different populations and groups, and its cultural and biological implications.

Fecal testosterone and corticosterone levels and behavioral correlates in a group of five captive chimpanzees (*Pan troglodytes*). C. SANZ, S. MONFORT, and R. FOUTS. Washington University, St. Louis, MO 63130; Conservation and Research Center, National Zoological Park, Smithsonian Institution, Front Royal, VA 22630; Chimpanzee and Human Communication Institute, Central Washington University, Ellensburg, WA 98926.

The present study incorporated noninvasive sampling techniques to examine baseline hormone levels and behavioral correlates in a small group of socially housed chimpanzees (*Pan troglodytes*). Fecal sample and behavioral data were collected seven days a week

for six weeks. Hormones were extracted and techniques validated for each sex. A radioimmunoassay (RIA) procedure was used to measure testosterone and corticosterone in fecal sample extracts. High performance liquid chromatography (HPLC) was used to characterize immunoreactive fecal testosterone metabolites. Specific behavioral measures included female sex skin swelling phase, male body odor, behavioral context, and arousal level.

Parallelism between hormone standards and chimpanzee fecal extracts was demonstrated for both hormones. Quantitative recovery of unlabeled steroids confirmed the absence of interfering substances in fecal extracts. There were no differences ( $P > 0.05$ ) between males and females in absolute hormone concentrations. RIA of fecal extracts after HPLC revealed that the testosterone antiserum employed did not crossreact with other androgen metabolites in chimpanzee feces. In general, corticosterone and testosterone excretion was relatively steady despite several high arousal interactions. In one instance, testosterone concentrations increased in the dominant female two days after a stressful event.

These data revealed that fecal testosterone and corticosterone metabolites can be readily documented in chimpanzee feces, but further work is needed to determine the physiological validity of these methods. However, this approach has potential for improving our understanding of the interrelationships between hormones and social behaviors in chimpanzees.

The postcranial morphology of *Ptilocercus lowii* (Scandentia, Tupaiidae) and its significance for the systematics of scandentians, primates, and other archontan mammals. E.J. SARGIS, City University of New York (CUNY) Ph.D. Program in Anthropology and New York Consortium in Evolutionary Primatology (NYCEP), Dept. of Anthropology, Hunter College-CUNY, 695 Park Ave., New York, NY 10021.

Tupaids (tree shrews), now placed in their own order Scandentia, were once included in the order Primates, and the two are still considered to be close relatives within the cohort Archonta. Due to this proposed close relationship, tupaids are often chosen as an outgroup in studies of primate systematics. The Tupaiidae includes two subfamilies, Ptilocercinae and Tupaiinae. The Ptilocercinae, represented only by *Ptilocercus lowii*, has been said to be the more plesiomorphic of the two groups, most closely approximating the ancestral tupaid. In this study, the postcranium of *Ptilocercus* was analyzed functionally and compared to that of tupaiines, euprimates, plesiadapiforms, dermopterans (flying lemurs), and chiropterans (bats). Several differences in many regions of the postcranium were found between *Ptilocercus* and tupaiines, and the proposed ancestral nature of the *Ptilocercus* postcranium was corroborated based on both outgroup and functional comparisons. Hence, in studies of primate supraordinal relationships that include comparisons of postcranial characters to those in tupaids, *Ptilocercus*

should be chosen to represent Scandentia. Similarly, if tupaiids are chosen as an outgroup in primate phylogenetic analyses that include postcranial evidence, then *Ptilocercus* should be used as the outgroup because its attributes are more conservative for the order. This stands in contrast to the many studies that have typically included *Tupaia glis*, the common tree shrew, as the representative for tupaiids. While the use of *Ptilocercus* may present a practical problem in that there are only six postcranial specimens known in museum collections, the results of this study confirm the necessity of incorporating *Ptilocercus* into any phylogenetic analysis that includes scandentians.

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**Patterns of paleodiet and bio-cultural practices of the inhabitants of Neolithic Ain Ghazal in Jordan. I. SARIE', Al-Quds University/Hebrew University of Jerusalem**

The purpose of this study is to reconstruct dietary practices at Ain Ghazal, a Neolithic site in Jordan, by means of chemical analysis of dental calculus present on the teeth. The main focus is the identification of pollen grains, spores and opal phytoliths. The calculus extracted from six Pre-Pottery Neolithic B and C individuals was cleaned with distilled water and divided into two tubes. One sample was soaked in 43% hydrofluoric acid (HF) for about 20 hours to remove all the silicates, leaving only the starch and pollen grains, while the second sample was not soaked with HF, so that both phytoliths and pollen grains could be extracted. Both samples were covered with 10ml of hydrochloric acid (HCL) (10% concentration) and centrifuged at 2000 r.p.m. for 8 mins. Slides prepared from the solutions were examined under a reflection microscope.

This approach not only provides a further indication of the site flora and climate, but also sheds light on the mobility and wide circulation of Ain Ghazal inhabitants in searching for game and gathering different types of fruit and plants to insure their biological survival. The site location in the Mediterranean vegetation belt apparently enabled them to have easy access to the exploitation of a wide variety of useful and edible plants present in the area. In comparing this analysis with the botanical and carbonized grains derived from the excavation of different spots and hatches, the extracted pollen grain and opal phytoliths indicate that wild and domesticated plants (cereals) were an integral part of the subsistence of the people of Ain Ghazal. Traces of inedible plants, such as reeds, atriplex and typha, were also found, indicating that these plants were used in basketry and weaving crafts, much in the same manner as can be seen today in ethnological observation of the modern inhabitants of the same area.

Dental calculus analysis provides evidence of the daily life activities of the people of Ain Ghazal within their environmental context by means of: 1) inferring their paleodiet through the evidence of the types of plants they actually consumed, rather than predicting their diet indirectly from the excavations; and 2) inferring the types of bio-cultural activities conducted at the site that reflect directly and indirectly their daily life activities (food preparation and preservation, and basketry and weaving work). The process of food preparation, mainly grinding cereals on grinding stones for making bread, burghul and Fareike, food preservation, in particular drying fruit and meat, was

known among the people of Ain Ghazal and undoubtedly contributed to the severe dental wear, ante-mortem tooth loss and masticatory disfunction.

**Gender Differences in The Work of Aymara Children at High Altitude. I. SARTON-MILLER**  
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Not only is it well documented that children work in many countries, but also that gender differences in child labor prevail in many cultures. The latter are usually explained as a reflection of societal norm surrounding gender roles. The high altitude environment of the Aymara people of the Bolivian Andes (altitude, 4000 m) is unique in that it allows a hypothesis regarding children's gender-specific patterns, viz., one that is based on a sex-specific biological adaptation to hypoxia. It is well documented that with limited energy (nutrition) available, "energy conserving" strategies have been adapted, whereby, for example, calories are preferentially given to children to do tasks that do not require adult strength, because children use fewer calories than do adults and are, therefore, more economical to feed. No studies, however, have been done on children's gender-specific subsistence tasks and whether these latter may be related to the hypoxic environment. Girls, it has been suggested, adapt to hypoxic stress at an earlier age than do boys, reaching cardiovascular and respiratory maturity earlier than do boys. The hypothesis is set forth here that sexually dimorphic developmental physiological responses as these, result in girls more "functionally fit" than boys of the same age, which in turn may influence the type and amount of subsistence labor performed by the two genders. I have conducted a pilot study in which 1) I interviewed parents regarding the benefit they expect from child labor and their expectations for boys and girls; 2) assessed the growth and physiological status of 10 boys and 10 girls, 11 years of age, by anthropometry; and 3) quantified each child's after-school time budget using focal-sample behavioral methodology. This study produced, first, a detailed description of the work activities pursued by Aymara children in the highly hypoxic environment they inhabit; and secondly, enabled me to address a relatively neglected question in studies of child labor, viz., the association of gender differences in work activity with size and/ functional physiological status.

Comparison of morbidity by demographic units between a poorhouse group and the surrounding community. L. P. SAUNDERS.  
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Rochester, NY 14607

As was true of most such institutions in the early to mid-19th century, the Highland Park Poorhouse in Rochester, NY was an integral part of the larger community. Inhabitants, for the most

part, derived from and returned to the surrounding community; occupation of the institution was usually of short duration. According to historical sources, there was no stigma associated with temporary residence in the poorhouse in the early years of its existence.

Historical records also describe the same epidemic disease processes (such as cholera) obtaining in both the poorhouse and local community at the same time. This presentation compares the two communities relative to these disease processes – both epidemic and endemic – by demographic units, since in the case of so-called childhood illnesses there is a presumed immunization process involved. The results suggest that certain diseases, such as tuberculosis, were more prevalent in the poorhouse than in the surrounding community, while other common seasonal illnesses ("Genesee Fever," for example) are not mentioned in the poorhouse records. Both of these situations may be attributed to the relative isolation and crowding characteristic of public institutions.

Ancient DNA analysis of a 2,000 year old Italian cemetery population. S.R.Saunders<sup>1</sup>, L.Bondiolli<sup>2</sup>, R.Macchiarelli<sup>3</sup>, S.Garagna<sup>3</sup>, C.Savore<sup>3</sup>, J.S.Waye<sup>4</sup> and D.Y.Yang<sup>1,4</sup> <sup>1</sup>Department of Anthropology, McMaster University, Hamilton, Ontario, L8S 4L9, <sup>2</sup>L. Pigorini National Museum of Prehistory and Ethnography, Rome, Italy, <sup>3</sup>Department of Animal Biology, University of Pavia, Pavia, Italy, <sup>4</sup>Department of Pathology and Molecular Medicine, McMaster University

Isola Sacra is an Imperial Roman cemetery located near the mouth of the Tiber River in Italy. Beginning, in the first century A.D., Emperor Claudius ordered the construction of a sea harbour north of Ostia to improve on the earlier river port. The cemetery associated with this second port (Portus Romae) was used from the first to the third centuries A.D. Almost 2,000 individuals have been unearthed, representing one of the largest Imperial Roman skeletal samples.

Most of the individuals interred in Isola Sacra lived and worked in the newly built port, Portus. They could have originally come from the local area in Italy or from other Mediterranean regions. Burial inscriptions suggest a heterogeneous, egalitarian population of commerce, including freedmen, freedwomen and sometimes slaves.

This study attempts to use ancient DNA analysis to examine mitochondrial DNA (mtDNA) variability in this skeletal population. Two independent research groups worked on the same set of bone samples (0.5 to 1 gm bone). DNA was extracted using the silica-based spin column method. D-loop hypervariable regions were amplified using overlapping primers. The sequences were determined from PCR products by means of fluorescent cycle sequencing with ABI automated DNA sequencers.

Preliminary results suggest that mtDNA variation is not as great as might be expected for a widely diverse Mediterranean population. We explore the cultural and geographic factors that might affect genetic variability.

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Microstructural preservation of archaeological bone tissue. C. SAVORÈ, D. FORMENTI, Dept. of Animal Biology, Univ. of Pavia, Italy, L. BONDIOLI and R. MACCHIARELLI, National Prehistoric Ethnographic "L. Pigorini" Museum, Rome, Italy.

The extraction of reliable histological information from archaeological bones largely depends on the nature and severity of the diagenetic changes following deposition.

A study has been performed on a sample of 400 thin sections of human cortical bone (femur shaft) from the Roman necropolis of Isola Sacra (2<sup>nd</sup>-3<sup>rd</sup> cent. AD). The site, at the delta of the Tiber river, is characterized by peculiar ground typology and sediment dynamics. After abandonment, it underwent intermittent fluctuations in groundwater, sand deposition and erosion.

The main goals of the ongoing histological research are: (i) the extensive investigation and documentation of the differential impact on bone of diagenetic agents; (ii) the estimation of the degree of correlation between the macroscopic and microscopic preservation of the remains; and (iii) the evaluation of the relationships between bony microstructures and the quality of the physico-chemical and biomolecular records.

By means of different microscopic (i.e., polarized and ultraviolet light microscopy) and digital image processing techniques, four major microstructural states of bone preservation/alteration have been defined: normal, focalized, amorphous, and mineralized.

In the investigated sample, the external macroscopic preservation quality of the bone and its inner microstructural appearance do not necessarily correspond. Also, no correlation has been recorded between micro-features and burial typology (interments in sand, brick or wooden coffin, amphora, *sarcophagus*, 'cappuccina', etc.). In collaboration with colleagues at the McMaster Univ., Hamilton, Canada, physico-chemical and biomolecular investigation is currently in progress on the same sample.

This research is supported by the Italian National Research Council (CNR, "Cultural Heritage" Project).